II. TARGET POPULATION AND SAFETY CONCERNS

Advanced air bags have the potential to improve the benefits of air bag systems and to reduce air bag induced fatalities and serious injuries. This chapter estimates the size of the potential target population that would benefit from advanced air bags. Fatalities and injuries are discussed in separate sections.

A. Fatalities

Fatalities reported here were derived from NHTSA s 1997 Fatality Analysis Reporting System (FARS). In 1997, there were a total of 18,136 drivers and right front passengers killed in frontal crashes (see Table II-1) which accounted for about 63 percent of all occupant fatalities. Of the 18,136 fatalities, 14,004 (77 percent) were drivers and 4,132 were right front-seated passengers. The majority (68 percent) of these fatalities were unrestrained occupants[1].

Table II-2 shows these fatalities disaggregated by impact speeds and belt use. Note that fatal frontal crashes in FARS are categorized by initial or principal point of impacts (IMPACT1 or IMPACT2). Occupants are considered to be in frontal crashes if their vehicles had an impact force from a 10-2 o clock direction. Distribution by crash impact speeds was also derived from

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[1]. The restraint use distribution was based on the 1993 to 1997 National Automotive Sampling System (NASS) Crashworthiness Data System (CDS), so that this table would be consistent with Table II-2. Table II-2 provides a distribution of fatalities by delta v. Delta v is only available in NASS-CDS.

Table II-1
1997 Driver and Right Front Passenger Fatalities

All Impact Modes	Drivers	Right Front Passengers	Total
Passenger Cars	14,843	4,987	19,830
Restrained	5,499	1,875	7,374
Unrestrained	9,344	3,112	12,456
Light Trucks/Vans	6,937	1,969	8,906
Restrained	2,559	746	3,305
Unrestrained	4,378	1,223	5,601
Total	21,780	6,956	28,736
Restrained	8,058	2,621	10,679
Unrestrained	13,722	4,335	18,057
Frontal Impacts*			
Passenger Cars	9,489	2,992	12,481
Restrained	3,036	957	3,993
Unrestrained	6,453	2,035	8,488
Light Trucks/Vans	4,515	1,140	5,655
Restrained	1,445	365	1,810
Unrestrained	3,070	775	3,845
Total	14,004	4,132	18,136
Restrained	4,481	1,322	5,803
Unrestrained	9,523	2,810	12,333

Source: NHTSA 1997 Fatality Analysis Reporting System (FARS), 1993-97 Crashworthiness Data System (CDS)
* Frontal crashes are defined as initial or principal impact force from 10-2 o clock direction.

the 1993 to 1997 CDS.   Because of variations in data elements describing crash characteristics,

it is not possible to establish a one-to-one association between FARS and CDS; hence frontal

crashes are defined somewhat differently for these two databases. Frontal crashes in the NASS

CDS are defined by their principal direction of force (DOF1), their general area of damage (GAD1), and the primary specific horizontal location (SHL1) as either:

DOF1 = 11, 12, or 1 o clock,

or

DOF1 = 10 or 2 and

GAD1 = F (front)

or

DOF1 = 10 or 2, and

GAD1 = L (left side) or GAD1 = R (right side), and

SHL1 = F (front)

Table II-2
Fatalities In Frontal Impacts By Crash Severity

	Crash Severity (Speed in MPH)				
Actual Fatalities (1997)	0-25	26-30	31-35	36+	Total
Drivers	4,630	2,375	1,868	5,131	14,004
Restrained	1,598	525	680	1,678	4,481
Unrestrained	3,032	1,850	1,188	3,453	9,523
Passengers	1,366	701	551	1,514	4,132
Restrained	471	155	201	495	1,322
Unrestrained	895	546	350	1,019	2,810
Total	5,996	3,076	2,419	6,645	18,136
Restrained	2,069	680	881	2,173	5,803
Unrestrained	3,927	2,396	1,538	4,472	12,333

Source: NHTSA 1993-1997 CDS and 1997 FARS.
Note: Fatalities by crash speeds and belt use were derived from 1993-1997 CDS and adjusted to 1997 FARS level.

The agency has estimated that air bags have saved over 4,547 lives cumulatively from 1987 through August 1, 1999. In calendar year 1997, about 36 percent of the on-road passenger cars and 28 percent of light trucks/vans were equipped with driver side air bags, and 22 percent of passenger cars and 17 percent of light trucks/vans were equipped with passenger side air bags. Air bags saved 842 lives in 1997. If one assumes that all passenger vehicles (cars, utility vehicles, light trucks, and vans) had been equipped with air bags, they would have saved an estimated 3,253 lives annually. In total, there would have been 18,978 (=18,136 + 842) potential fatalities associated with frontal impacts if no vehicles had air bags in 1997. Potential fatalities are defined here as people in frontal crashes that died plus those would have been fatally injured in the absence of air bags.

Table II-3 shows, by several crash impact speed levels, the potential fatalities, lives that would have been saved, and the remaining fatalities if all vehicles in the fleet were equipped with pre-98 air bag systems. Advanced air bags have the potential to reduce the remaining fatalities. Belt use in Table II-3 is the same as found in 1993-1997 CDS at 32 percent.

As shown in Table II-3, an entire fleet of pre-MY 1998 air bags would save about 3,253 lives annually, and thus, are an important source of occupant protection in current passenger vehicles. However, air bags may have adverse effects on occupants who are too close to the air bags when they deploy. Of particular concern are children. As of August 1, 1999, NHTSA s Special Crash Investigation (SCI) Program has identified a total of 164 cases (137 confirmed and 27 still under investigation) of < 25 mph v in which the deployment of an air bag resulted in fatal injuries to

an occupant between 1990 and 1998. Of these 164 fatalities, 17 were infants in rear-facing child safety seats (RFCSS), 77 were children aged one to twelve years old, 61 were drivers, and 9 were adult passengers. These cases were then projected to an annual basis under the assumption that all passenger vehicles were equipped with air bags (of the type typically produced during 1987-1997) by multiplying the actual number of incidents by an adjustment factor (f) that adjusts the vehicle fleet to a fleet in which all vehicles have air bags. By assuming that air bag-induced fatalities are proportional to the percentage of the fleet with air bags, the adjustment factor for each year is the ratio of the number of vehicles in operation to the number with air bags, i.e., f=1/r where r is the percentage of the fleet with air bags. The corresponding mathematical formula is:

$$Pd = Ad * f$$

where Pd = projected deaths

Ad= actual number of deaths from SCI cases

f = the ratio of the number of total vehicles to number of vehicles with air bags.

Table II-3
Estimated Lives Saved and Fatalities Remaining in Frontal Crashes
Assuming the Whole Fleet of Passenger Vehicles Had Air Bags

Potential Fatalities With No Air Bags	Crash Severity (Speed in MPH)				
	0-25	26-30	31-35	36+	Total
Drivers	4,865	2,496	1,963	5,391	14,715
Restrained	1,781	585	758	1,869	4,993
Unrestrained	3,084	1,911	1,205	3,522	9,722
Passengers	1,409	723	568	1,563	4,263
Restrained	505	166	215	530	1,416
Unrestrained	904	557	353	1,033	2,847
Total	6,274	3,219	2,531	6,954	18,978
Restrained	2,286	751	973	2,399	6,409
Unrestrained	3,988	2,468	1,558	4,555	12,569
Estimated Lives Saved with Full Fleet of Air Bags					
Drivers	1,093	583	439	359	2,474
Restrained	321	105	137	102	665
Unrestrained	772	478	302	257	1,809
Passengers	317	169	126	167	779
Restrained	91	30	38	51	210
Unrestrained	226	139	88	116	569
Total	1,410	752	565	526	3,253
Restrained	412	135	175	153	875
Unrestrained	998	617	390	373	2,378
Fatalities Remaining with Full Fleet of Air Bags					
Drivers	3,772	1,913	1,524	5,032	12,241
Restrained	1,460	480	621	1,767	4,328
Unrestrained	2,312	1,433	903	3,265	7,913
Passengers	1,092	554	442	1,396	3,484
Restrained	414	136	177	479	1,206
Unrestrained	678	418	265	917	2,278
Total	4,864	2,467	1,966	6,428	15,725
Restrained	1,874	616	798	2,246	5,534
Unrestrained	2,990	1,851	1,168	4,182	10,191

Source: NHTSA 1993-1997 CDS and 1997 FARS.
Note: Fatalities by crash speeds were derived from 1993-1997 CDS and adjusted to 1997 FARS level.

Table II-4 shows actual and projected fatalities by years. The actual fatalities, except calendar year 1998, were those fatalities caused by pre-MY 1998 air bags. For year 1998, fatalities caused by MY-1998 (redesigned) air bags were also included in the projection because pre-MY 1998 air bags deployed at a greater force and thus would have killed the same occupants if the pre-MY 1998 air bags were installed in the vehicles.

If all passenger vehicles were equipped with air bags, for example in the year 1998 (using the above formula Pd=Ad*f), about 15 (4*1/0.272) infants in RFCSS, 81 (22*1/0.272) children, 11 (3*1/0.272) adult passengers, and 25 (10*1/0.394) drivers would have been killed by air bags (and otherwise probably would not have died if had there been no air bag).

Table II-4
Projected At-Risk Fatalities by Years

| Year | Portion of Fleet with Air Bags | | SCI Cases as of 08/01/99 | | | | Projected Annual Number | | | |
	Driver	Passenger	RFCSS	Children 1-12 Years Old	Adult Passengers	Drivers	RFCSS	Children 1-12 Years Old	Adult Passengers	Drivers
90	0.018	0.001	0	0	0	1	0	0	0	56
91	0.027	0.001	0	0	0	4	0	0	0	148
92	0.050	0.003	0	0	0	3	0	0	0	60
93	0.083	0.008	0	1	0	4	0	125	0	48
94	0.128	0.026	0	5	0	7	0	192	0	55
95	0.188	0.065	3	6	0	4	46	92	0	21
96	0.258	0.126	6	18	2	7	48	143	16	27
97	0.328	0.201	4	25	5	21	20	124	25	64
98	0.394	0.272	4	22	3	10	15	81	11	25
98[1]	0.068[2]	0.068	0	2	1	1	See further discussion			

1. This row provides information for 1998 vehicle models with redesigned air bags in calender year 1998. These fatalities are included in the 1998 numbers above.
2. The number is derived by assuming 1998 model vehicles accounted for 7.84 percent of the fleet in operation and 87 percent of these new vehicles were equipped with redesigned air bags, i.e., 0.068=0.0784*0.87.

In late 1996, the agency started a much broader public awareness program on the potential adverse effect of air bags. In addition, the agency required 1998 new vehicles to have air bag warning labels. Increasing public awareness of the air bag occupant safety issue reduced the air bag risk to rear-facing infants and children. As shown in Table II-4, the number of air bag induced fatalities gradually reduced, especially from 1997 to 1998. To take the effectiveness of the public awareness into account and to reduce year by year fluctuation, this analysis uses the weighted average of 1997 and 1998 projected deaths to estimate an annualized baseline fatal population for the at-risk groups. These projected deaths were weighted by the number of on-road operational vehicles in the fleet. There were about 194,653,000 and 198,401,000 passenger vehicles on the road in 1997 and 1998, respectively. The annualized deaths can be written as following:

Annualized Deaths = $(194,653,000 * Pd_{97} + 198,401,000 * Pd_{98})/(194,653,000 + 198,401,000)$

where Pd_{97} =projected deaths in 1997

Pd_{98} =projected deaths in 1998.

Because more vehicles were on the road in 1998 than in 1997, the annualized projection thus gave a slightly greater weight to 1998 cases. In total, as shown in Table II-5, there would be approximately 18 infants in RFCSS, 102 children aged 1-12, 16 adult passengers, and 45 drivers[2]

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[2] The figures in the table are slightly different from the estimates in the Preliminary Economic Assessment, FMVSS No.208, Advanced Air Bags August 1998, NHTSA, because this analysis uses 1997 FARS and 1993-1997 CDS crash data. Also, this analysis used a different projection approach to estimate the annual at-risk population. Finally, the number killed by air bags was projected using later data from the Special Crash Investigation program, up to August 1, 1999.

killed by air bags if all vehicles in the fleet were equipped with pre-MY 1998 air bags. For

comparison purpose, the projected annual deaths for MY 1998 air bags are presented here. Note,

the projected numbers based on the performance of MY 1998 air bags were derived from analysis

of limited SCI data. Following is a detailed description of the analysis.

Table II-5
Estimated Annual At-Risk Fatalities With A Full Fleet of Air Bags
by Air Bag Types

At-Risk Group	Annual Deaths	
	Pre-MY 1998 Air Bags*	MY 1998 Air Bags**
Drivers	45	15
Adult Passengers	16	5
Children 1 to 12 Years Old	102	30
Infants in RFCSS	18	10
Total	181	60

*Annual deaths were projected using 1997 and 1998 fatal cases only.
** Based on judgement and analysis of minimal data.

An analysis of Special Crash Investigation (SCI) Fatalities by Model Year and Investigation Date

was undertaken to determine how well the redesigned air bags were performing, based on the

minimal data available. Table II-6 shows these data, which compare SCI Cases, including those

cases not on the official list yet in ( ). This analysis compares what was known to the SCI team

one year and nine months after the start of the new model year and compares MY 1996 vehicles

to MY 1997 vehicles to MY 1998 vehicles over the same length of time (vehicle months on the

road). The results are that there are still fatalities occurring to out-of-position occupants with the

redesigned air bags, but fatalities appeared to have been reduced from 14 in MY 96 and 17 in

MY 97, to five in MY 98. Table II-7 shows these data compared to Polk registrations (discussed further at length later in this analysis). The average of MY 96 and MY 97 data is a fatality rate of 1.14. Compared to this, the fatality rate for MY 1998 of 0.34, is about 30 percent. The agency does not know how much of this reduction is from redesign, media coverage (putting kids in rear seat), or luck. However, initial data indicate that redesigned air bags are making good progress towards reducing the out-of-position problem.

The data are not robust enough to have any confidence about how well redesigned air bags are working for the four individual categories of out-of-position occupants (rear facing infants, forward facing children, adult passengers, and drivers). However, the potential difference is significant enough that the agency will perform a sensitivity analysis, assuming redesigned air bags reduce the potential target population to 30 percent of its estimated total based on pre-MY 1998 models. For Table II-5, a distribution for the at-risk groups is provided based on the roughly one-third fatality rate. With no infant fatalities in rear facing child safety seats, the estimate of 10 is based on engineering judgment comparing the aggressiveness of pre-MY 1998 air bags to MY-1998 air bags, in general.

Table II-6
Special Crash Investigation Cases

MY and (dates investigated)	Rear Facing Infant Fatals	Forward Facing Child Fatals	Adult Passenger Fatals	Driver Fatals	Total Fatals
MY 1999 redesigned (9 months)	0	1	0	0	1
MY 1998 redesigned (10/1/97 to 7/1/99) (1yr.and 9 mos.)	0	1 + (1)* = 2	(1)	1 fetus	3 + 1 fetus
MY 1998 not redesigned (10/1/97 to 7/1/99) (1yr.and 9 mos.)	0	0	0	1	1
MY 1997 (10/1/96 to 7/1/98) (1yr.and 9 mos.)	2	6 + (2) = 8	1 + (2) = 3	2 + (2) = 4	17
MY 1996 (10/1/95 to 7/1/97) (1yr.and 9 mos.)	1	8 + (1) = 9	0	4	14

* Cases under investigation, but not on official list yet.

Table II-7*
SCI Cases per Million Registered Vehicles

	SCI Fatalities Over the First 21 Months of the MY Life	Total Registrations from Polk (millions of vehicles)	SCI Fatalities per Million Vehicles Registered
MY 1996 (10/01/95 to 07/01/97)	14	13.103	1.07
MY 1997 (10/01/96 to 07/01/98)	17	14.174	1.20
MY 1998 (10/01/97 to 07/01/99)	5	14.569 (estimated)	0.34

* See endnote at the end of this chapter.

Table II-8 presents the same statistics from the analysis described above but for fatalities that occurred over the last 21 months (10/01/97 to 07/01/99). The comparison indicates fatalities are a little lower over the last 21 month period. The MYs 96-97 averaged 15.5 fatalities (see Table II-7) over the first 21 months and 13 fatalities over the last 21 months. The data still show that redesigned air bags perform better for out-of-position occupants. However, statistics for MY 1998 redesigned air bags were based on limited data and might not be a reliable indication of any trend.

Table II-8
SCI Cases per Million Registered Vehicles

	SCI Fatalities Over the Last 21 Months Passed (10/01/97-07/01/99)	Total Registrations from Polk (millions of vehicles)	SCI Fatalities per Million Vehicles Registered
MY 1996	11	13.103	0.84
MY 1997	15	14.174	1.06
MY 1998	5	14.569 (estimated)	0.34

Another analysis to assess the impact of the MY 1998 redesigned air bags on baseline population estimation is to examine the 1998 FARS. A First Cut Analysis of FARS, for MY 1998 redesigned vehicles over the first 12 months of 1998, compared to MY 1997 vehicles over the 12 months of 1997, and MY 1996 vehicles over the 12 months of 1996, was undertaken. The question we were trying to answer is whether the frontal fatality rate increased with the decrease in power in redesigned air bags in MY 1998 vehicles. Testing results showed no difference for belted occupants and a slight difference for unbelted occupants. Most vehicles met the 30 mph

unbelted test anyway. We would expect that no difference could be found without substantially more data. No statistically significant difference was found.

The percent of fatalities that were frontal are:

> 38.9 % for MY 96 vehicles in calendar year 1996
> 41.3 % for MY 97 vehicles in calendar year 1997
> 39.6 % for MY 98 vehicles in the 6-month file of calendar year 1998.

The most relevant comparison might be the 39.6 % for MY 1998 vehicles to all the data available for MY 1997 vehicles (in calendar year 1997 and the 6-month file of 1998) of 40.3%. This results in a risk ratio of 0.972, or a 2.8 percent reduction in frontal fatalities. This is not a statistically significant difference.

These pre-MY 1998 air bags, would save 3,253 lives annually, however, 181 occupants would be killed by the air bags. Thus, the net estimated lives saved would be 3,072 (3,253 - 181). Table II-9 summarizes these estimates in detail. It is important to note that the projections were based on all identified (confirmed and unconfirmed) cases. However, there are 5 unconfirmed cases in 1997 and 14 unconfirmed cases in 1998, therefore, the projected annualized at-risk population could be smaller. Equally important is the fact that all the estimates are based on the assumption that, in the future years, there are no changes in occupant demographics, driver/passenger behavior, belt use, child restraint use, or the percent of children sitting in the front seat. As public

education programs are more successful in creating better awareness of occupant safety issues, and as auto manufacturers voluntarily phase in improved air bags, the potential negative safety impacts of air bags would be further reduced.

Table II-9
Estimated Full Fleet Impacts of Pre-MY 1998 Air Bags on Fatalities

	Saved	Killed	Net Impacts
Drivers	2,474	45	2,429
Passengers	779	136	643
Adults	779	16	763
Children	0*	102	-102
RFCSS	0	18	-18
Total	3,253	181	3,072

* Potentially there are benefits from air bags for correctly positioned children in high severity impacts. Sled test data do show a reduction in injury measures for correctly positioned child dummies with air bags compared to belted child dummies in 30 mph impacts. This does not appear to be the case for infants in rear facing child safety seats. All RFCSS tests have indicated an increased probability of head injury with air bags. Statistical analyses have shown negative effectiveness of air bags for children. This implies that the negative impacts of air bags for children at low speeds are overwhelming the benefits, if any, for children at high speeds. It is impossible to prove that an air bag saved a life in a particular high speed crash, since about 50 percent of unbelted occupants survive (with injuries) in crashes with a change in velocity (delta V) of 30 to 40 mph. Until there are enough data available to do a statistical analysis of the effectiveness of air bags for children at different speeds, the agency cannot estimate the benefits of air bags for children under the age of 12.

B. Injuries

The injury population assessment uses two data sources: the 1993-1997 CDS and the 1997 General Estimates System (GES)[3]. GES is the main database used by the agency to produce national statistics on nonfatal crashes in the U.S. However, GES is a sample taken directly from police-reported crashes and does not provide in-depth investigations of injury profiles and crash

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[3] General Estimates System Coding Manual 1997.

configurations as does CDS.   This analysis uses GES to estimate the size of injury populations
and CDS to describe crash characteristics such as MAIS injury severity and delta v for crash
severity.

CDS contains data on all passenger vehicle crashes where at least one passenger vehicle was
towed, while GES is a sample of all police-reported crashes not limited to passenger vehicle tow-
away crashes. Therefore, injury counts derived from CDS were adjusted only to the GES CDS-
equivalent level. As with FARS, this adjustment cannot establish a one-to-one association
between GES CDS-equivalent crashes and CDS crashes. CDS equivalent frontal crashes in GES
are defined by Hotdeck imputed initial point of impact (IMPACT_H) from 10, 11, 12, 1, or 2
o clock.

In 1997, there were 291,859 driver and right front passenger MAIS 2-5 and 1,678,192 MAIS 1
non-fatal injuries associated with frontal crashes. MAIS 1-5[4] injuries reported in Table II-10 and
Table II-11 were adjusted to 1997 GES CDS-equivalent injury levels.

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[4]. Maximum Abbreviated Injury Scale, 1-Minor Injury, 2-Moderate Injury, 3-Serious Injury, 4-Severe
Injury, 5-Critical Injury. Only one injury with the most severity is counted per occupants.

Table II-10
1997 Drivers and Right Front Passengers With MAIS 2-5 Injuries

All Impact Modes	Drivers	Right Front Passengers	Total
Passenger Cars	257,372	77,046	334,418
Restrained	141,588	42,274	183,862
Unrestrained	115,784	34,772	150,556
Light Trucks/Vans	74,352	22,105	96,457
Restrained	41,182	12,214	53,396
Unrestrained	33,170	9,891	43,061
Total	331,724	99,151	430,875
Restrained	182,770	54,488	237,258
Unrestrained	148,954	44,663	193,617
Frontal Impacts			
Passenger Cars	172,148	49,666	221,814
Restrained	98,124	28,310	126,434
Unrestrained	74,024	21,356	95,380
Light Trucks/Vans	54,362	15,683	70,045
Restrained	30,987	8,939	39,926
Unrestrained	23,375	6,744	30,119
Total	226,510	65,349	291,859
Restrained	129,111	37,249	166,360
Unrestrained	97,399	28,100	125,499

Source: NHTSA 1997 National Automotive Sampling System - General Estimated System (NASS-GES) and - 1993-1997 Crashworthiness Data System (CDS)
Note: MAIS 2-5 injuries were derived from 1993-1997 CDS and adjusted to 1997 GES-CDS equivalent level.

Table II-11
1997 Drivers and Right Front Passengers With MAIS 1 Injuries

All Impact Modes	Drivers	Right Front Passengers	Total
Passenger Cars	1,537,716	461,589	1,999,305
Restrained	1,138,969	342,240	1,481,209
Unrestrained	398,747	119,349	518,096
Light Trucks/Vans	441,094	131,469	572,563
Restrained	325,854	97,211	423,065
Unrestrained	115,240	34,258	149,498
Total	1,978,810	593,058	2,571,868
Restrained	1,464,823	439,451	1,904,274
Unrestrained	513,987	153,607	667,594
Frontal Impacts			
Passenger Cars	989,850	285,577	1,275,427
Restrained	722,591	208,471	931,062
Unrestrained	267,259	77,106	344,365
Light Trucks/Vans	312,583	90,182	402,765
Restrained	228,185	65,833	294,018
Unrestrained	84,398	24,349	108,747
Total	1,302,433	375,759	1,678,192
Restrained	950,776	274,304	1,225,080
Unrestrained	351,657	101,455	453,112

Source: NHTSA 1997 National Automotive Sampling System - General Estimated System (NASS-GES) and - 1993-1997 Crashworthiness Data System (CDS)
Note: MAIS 1 injuries were derived from 1993-1997 CDS and adjusted to 1997 GES-CDS equivalent level.

Air bags proved to be 10 percent[5] (not statistically significant) effective in reducing MAIS 2-5

injuries. Annually, air bags would reduce about 30,211 MAIS 2-5 injuries. Table II-12 shows

three types of MAIS 2-5 injury estimates in frontal crashes by person role (driver, passenger) and

crash impact speeds. These estimates are: number of MAIS 2-5 injuries with no air bags

(potential MAIS 2-5 injuries), injuries reduced, and number of remaining MAIS 2-5 injuries if

the whole fleet had air bags. There would be a total of 271,892 MAIS 2-5 injuries remaining

annually if all vehicles had pre-MY 1998 air bags. Advanced air bags would have the potential

to further reduce these remaining injuries. Note that the distribution of MAIS 2-5 injuries by

person role, crash impact speeds (delta v), and restrained use were derived from 1993-1997 CDS

statistics. Of the total shown, MAIS 2 injuries were 63.8 percent, MAIS 3 were 28.2 percent,

MAIS 4 were 6.1 percent, and MAIS 5 were 1.9 percent. Belt use in Table II-12 is the same level

found in 1993-1997 CDS at 57 percent.

A table like Table II-12 was not derived for MAIS 1 injuries since the agency believed the

effectiveness of air bags for AIS 1 injuries is minimal. Many occupants have a red face from

 bag slap which is considered an AIS 1 injury. Thus, the effectiveness of reducing overall AIS 1

injuries with pre-MY 1998 air bag is believed to be minimal.

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[5] The Fourth Report to Congress, Effectiveness of Occupant Protection Systems and Their Use, May 1999.

Table II-12
Estimated MAIS 2-5 Injuries Remaining
Assuming the Whole Fleet of Passenger Vehicles Had Air Bags

Potential Injuries With No Air Bags	Crash Severity (Speed in MPH)				
	0-25	26-30	31-35	36+	Total
Drivers	191,605	24,058	8,622	10,776	235,061
Restrained	116,721	8,761	4,455	3,937	133,874
Unrestrained	74,884	15,297	4,167	6,839	101,187
Passengers	54,583	6,854	2,457	3,148	67,042
Restrained	33,253	2,496	1,271	1,174	38,194
Unrestrained	21,330	4,358	1,186	1,974	28,848
Total	246,188	30,912	11,079	13,924	302,103
Restrained	149,974	11,257	5,726	5,111	172,068
Unrestrained	96,214	19,655	5,353	8,813	130,035
Estimated MAIS 2-5 Injuries Reduced with Full Fleet of Air Bags					
Drivers	19,161	2,406	862	1,078	23,507
Restrained	11,672	876	446	394	13,388
Unrestrained	7,489	1,530	416	684	10,119
Passengers	5,458	685	246	315	6,704
Restrained	3,325	250	127	117	3,819
Unrestrained	2,133	435	119	198	2,885
Total	24,619	3,091	1,108	1,393	30,211
Restrained	14,997	1,126	573	511	17,207
Unrestrained	9,622	1,965	535	882	13,004
MAIS 2-5 Injuries Remaining with Full Fleet of Air Bags					
Drivers	172,444	21,652	7,760	9,698	211,554
Restrained	105,049	7,885	4,009	3,543	120,486
Unrestrained	67,395	13,767	3,751	6,155	91,068
Passengers	49,125	6,169	2,211	2,833	60,338
Restrained	29,928	2,246	1,144	1,057	34,375
Unrestrained	19,197	3,923	1,067	1,776	25,963
Total	221,569	27,821	9,971	12,531	271,892
Restrained	134,977	10,131	5,153	4,600	154,861
Unrestrained	86,592	17,690	4,818	7,931	117,031

Source: NHTSA 1993-1997 NASS CDS and 1997 GES.

Note: Injuries by crash speeds were derived from 1993-1997 CDS and adjusted to 1997 GES CDS-equivalent level.

In addition to air bag induced fatalities, SCI also identified some cases where children and adults who sit too close to air bags were seriously injured when air bags deployed in low speed impacts. But these SCI cases are by no means comprehensive, and thus might underestimate air bag induced serious injuries if used as the basis to project annual at-risk serious injuries (MAIS 3-5). Instead, the at-risk fatalities were used as the basis. For each MAIS 3-5 injury level, the estimate of annualized at-risk fatalities is multiplied by the ratio (adjustment factors) of injuries to fatalities. The adjustment factors and the ratio of air bag induced injuries to fatalities were derived from 1993-1998 CDS nonweighted cases. The 1998 CDS data were used here to include more air bag induced cases. Because 1998 CDS does not have the appropriate national weights available yet, the nonweighted cases were used to derive the ratios of injuries to fatalities. The analysis for final rule will be updated using weighted cases. Table II-13 shows that annually a total of 9 RFCSS, 195 children, 14 adult passengers, and 37 drivers were seriously injured by air bags.

Table II-13
Projected Annualized At-Risk MAIS 3-5 Injuries

| Year | Projected Annual Number | | | |
	RFCSS	Children 1-12 Years Old	Adult Passengers	Drivers
Baseline (at-risk fatalities)	18	102	16	45
Adjustment Factors				
MAIS 5	0.5	0.8	0.1	0.1
MAIS 4	0.0	0.8	0.1	0.1
MAIS 3	0.0	0.3	0.6	0.6
Projected Injuries				
MAIS 5	9	82	2	5
MAIS 4	0	82	2	5
MAIS 3	0	31	10	27
Total MAIS 3-5	9	195	14	37

Source: SCI cases August 1, 1999. 1993-1998 CDS
Note: Baseline is the projected annualized at-risk fatalities.

The following Tables II-14 to II-16 show fatalities and different MAIS injury levels by crash severity (delta v) in frontal crashes. Broken out further, Table II-14 presents these statistics for all front-outboard occupants, belted and unbelted combined; Table II-15 presents statistics for unbelted front-outboard occupants; while Table II-16 presents statistics for belted front-outboard occupants. These tables serve as additional background information to make a necessary adjustment of the overall target population and to analyze benefits for these tests. Figure II-1 graphically depicts the cumulative percentages of fatalities and MAIS 2-5 injuries by crash impact speeds (delta v). Figure II-2 shows the percentage distribution by principal direction of force.

Table II-14
Front-Outboard Occupant Fatalities and MAIS 2-5 Injuries
in Frontal Crashes by Crash Impact Speeds

Delta V (MPH)	Fatal %	Fatal Cumulative %	MAIS 4-5 %	MAIS 4-5 Cumulative %	MAIS 3-5 %	MAIS 3-5 Cumulative %	MAIS 2-5 %	MAIS 2-5 Cumulative %
0-10	2.2	2.2	4.2	4.2	3.9	3.9	12.0	12.0
11	1.1	3.3	0.5	4.7	6.0	9.9	5.8	17.8
12	2.1	5.4	1.4	6.1	8.1	18.0	5.5	23.3
13	0.4	5.8	3.7	9.8	1.7	19.7	3.5	26.8
14	2.2	8.0	4.9	14.7	7.5	27.2	7.8	34.6
15	1.8	9.8	0.2	14.9	4.6	31.8	3.5	38.1
16	1.8	11.6	3.0	17.9	5.6	37.4	5.8	43.9
17	1.0	12.6	2.7	20.6	9.1	46.5	12.2	56.1
18	0.4	13.0	1.7	22.3	1.4	47.9	3.6	59.7
19	2.4	15.4	3.1	25.4	2.8	50.7	4.4	64.1
20	0.7	16.1	2.1	27.5	2.6	53.3	1.9	66.0
21-25	16.7	32.8	22.7	50.2	19.2	72.5	15.7	81.7
26-30	16.7	49.5	15.3	65.5	13.5	86.0	10.4	92.1
31-35	13.5	63.0	7.8	73.3	5.8	91.8	3.9	96.0
36-40	13.0	76.0	17.8	91.1	4.8	96.6	2.3	98.3
41+	24.1	100.1	8.9	100.0	3.5	100.1	1.7	100.0

Source:1993-1997 CDS.
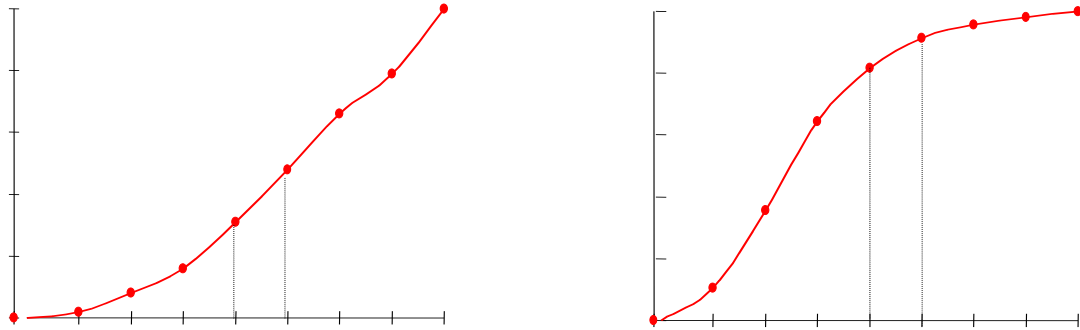
Note: Fatalities and MAIS 2-5 injuries with unknown crash impact speeds were excluded in the analysis.

Figure II-1. Percent of Front-Outboard Fatalities/MAIS 2-5 Injuries in Frontal Crashes
by Crash Impact Speeds (Delta V)

Table II-15
Front-Outboard Occupant Unbelted Fatalities and MAIS 2-5 Injuries
in Frontal Crashes by Crash Impact Speeds

Delta V (MPH)	Fatal %	Fatal Cumulative %	MAIS 4-5 %	MAIS 4-5 Cumulative %	MAIS 3-5 %	MAIS 3-5 Cumulative %	MAIS 2-5 %	MAIS 2-5 Cumulative %
0-10	3.1	3.1	5.7	5.7	5.8	5.8	10.6	10.6
11	1.3	4.4	0.8	6.5	0.9	6.7	3.2	13.8
12	1.5	5.9	1.6	8.1	2.0	8.7	3.1	16.9
13	0.4	6.3	4.0	12.1	1.7	10.4	3.8	20.7
14	2.3	8.6	4.9	17.0	12.7	23.1	8.2	28.9
15	0.6	9.2	0.0	17.0	1.3	24.4	1.8	30.7
16	1.1	10.3	3.8	20.8	5.0	29.4	4.1	34.8
17	0.5	10.8	2.5	23.3	4.0	33.4	10.6	45.4
18	0.3	11.1	1.5	24.8	1.1	34.5	1.4	46.8
19	3.1	14.2	2.4	27.2	2.9	37.4	4.2	51.0
20	1.0	15.2	1.1	28.3	1.7	39.1	1.4	52.4
21-25	16.6	31.8	19.9	48.2	26.1	65.2	22.5	74.9
26-30	19.2	51.0	13.4	61.6	16.9	82.1	15.3	90.2
31-35	12.6	63.6	7.1	68.7	7.3	89.4	4.4	94.6
36-40	13.0	76.6	21.9	90.6	6.3	95.7	2.7	97.3
41+	23.3	99.9	9.5	100.1	4.3	100.0	2.7	100.0

Source:1993-1997 CDS.
Note: Fatalities and MAIS 2-5 injuries with unknown crash impact speeds were excluded in the analysis.

Table II-16
Front-Outboard Occupant Belted Fatalities and MAIS 2-5 Injuries
in Frontal Crashes by Crash Impact Speeds

Delta V (MPH)	Fatal %	Fatal Cumulative %	MAIS 4-5 %	MAIS 4-5 Cumulative %	MAIS 3-5 %	MAIS 3-5 Cumulative %	MAIS 2-5 %	MAIS 2-5 Cumulative %
0-10	0.6	0.6	1.1	1.1	2.1	2.1	13.2	13.2
11	0.0	0.6	0.0	1.1	11.2	13.3	7.9	21.1
12	3.6	4.2	1.1	2.2	14.3	27.6	7.2	28.3
13	0.5	4.7	3.1	5.3	1.6	29.2	3.2	31.5
14	2.2	6.9	4.8	10.1	2.3	31.5	7.5	39.0
15	4.9	11.8	0.7	10.8	7.9	39.4	4.8	43.8
16	3.6	15.4	1.5	12.3	6.1	45.5	7.2	51.0
17	2.1	17.5	3.4	15.7	14.3	59.8	13.4	64.4
18	0.6	18.1	2.0	17.7	1.7	61.5	5.4	69.8
19	1.1	19.2	4.7	22.4	2.6	64.1	4.6	74.4
20	0.0	19.2	4.2	26.6	3.6	67.7	2.4	76.8
21-25	16.5	35.7	28.8	55.4	12.3	80.0	10.4	87.2
26-30	11.7	47.4	18.9	74.3	10.0	90.0	6.7	93.9
31-35	15.2	62.6	9.3	83.6	4.3	94.3	3.4	97.3
36-40	14.5	77.1	8.8	92.4	3.0	97.3	1.9	99.2
41+	23.0	100.1	7.6	100.0	2.6	99.9	1.0	100.2

Source:1993-1997 CDS.
Note: Fatalities and MAIS 2-5 injuries with unknown crash impact speeds were excluded in the analysis.

Data source: 1993-1997 CDS.

Figure II-2. Percent of Front-Outboard Passenger Fatalities/M AIS 2-5 Injuries in
Frontal Crashes by Principal Direction of Force

Endnote for Table II-7,

A small analysis was performed to examine the potential impact of the increase in belt use between 1996 and 1998 on the apparent change in fatality rates for redesigned MY 1998 air bag vehicles. Results from the National Occupant Protection Use Survey (NOPUS) show that the observed average overall safety belt use in front seat outboard passenger cars and light trucks was 61.3 percent in 1996 and 68.9 percent in 1998. Thus, safety belt use increased during the period. The estimates use the average effectiveness of safety belts for passenger cars and light trucks of about 51 percent (45 percent for passenger cars and 60 percent for light trucks). It is estimated that instead of the 14 fatalities that occurred over the first 21 months of the MY 1996 vehicles shown in Table II-7 with 61.3 percent belt use, that there would have been 13 fatalities if belt use had been 68.9 percent [14/(1-0.51*0.613) = 20.37; 20.37*0.51*0.689 = 7.16; 20.37-7.16 = 13]. The SCI fatalities per million registered MY 1996 vehicles using 13 fatalities instead of 14 would be 0.99.

The same calculation for 1997, assuming average belt use in 1997 midway between 1996 and 1998 of 65.1 percent resulted in no change in the number of SCI fatalities of 17 and the fatality rate remaining at 1.20 for MY 1997 vehicles. Thus the average SCI fatality rate for MY s 1996/97 would be 1.10 [(0.99 + 1.20)/2]. Comparing this to MY 1998 rate of 0.34 results in 30.9 percent (0.34/1.10) rather than the previous estimate of 29.8 percent (0.34/1.14), still roughly 30 percent as used in the analysis for Table II-5.